



## **Foetal protein-malnutrition in mink causes changes in F2 progeny**

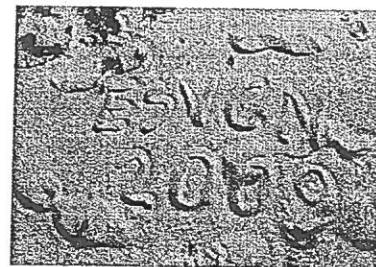
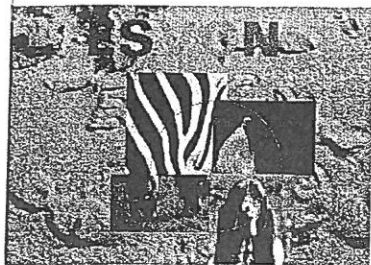
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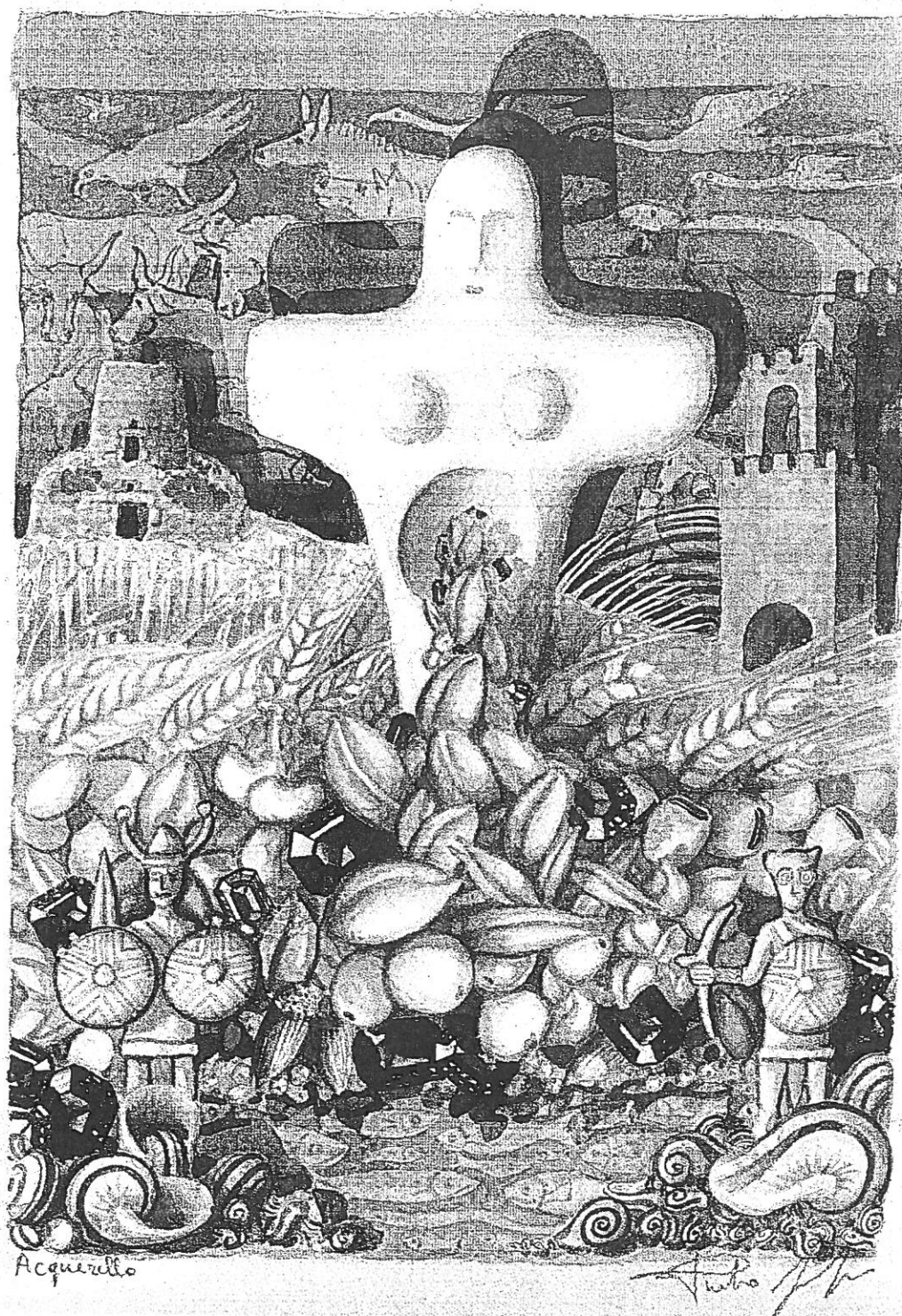


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## Foetal protein-malnutrition in mink causes changes in F<sub>2</sub> progeny

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**Introduction:** Malnutrition during foetal life can induce permanent metabolic changes in offspring, due to metabolic and structural adaptation to the available nutrient supply in order to maximize the outcome. These adaptations might result in permanent changes in the offspring, but depend on when the malnutrition occurs, i.e., during certain sensitive periods of foetal development (Lucas, 1991). Epigenetic modification and consequences are not necessarily limited to first-generation (F<sub>1</sub>) offspring, but can be passed on to subsequent generations (Pinheiro *et al.*, 2008). Our objectives were to investigate if low protein supply during foetal life affects the quantitative metabolism and expression of key hepatic gluconeogenic and glycolytic enzymes in yearling F<sub>1</sub> generation (F<sub>1</sub>) mink dams, despite adequate feeding postnatally and furthermore, if possible changes can be transmitted to the F<sub>2</sub> generation offspring (F<sub>2</sub>).

**Materials and Methods:** Forty-eight F<sub>1</sub> yearling female mink of the standard black genotype were used, 24 of which had been exposed to low protein supply (14% of metabolizable energy – ME – from protein; FL) and 24 to adequate protein supply (29% of ME from protein; FA) during the last 17.9 ± 3.6 days of foetal life. The dams had been given adequate protein supply from birth onwards. Forty F<sub>1</sub> dams were used to study reproductive performance and to record kit body weight (BW) at birth of the F<sub>2</sub> offspring and until 28 days of age. Sixteen F<sub>1</sub> animals, eight dams from each *in utero* treatment, were used in balance and respiration experiments in the first and last thirds of true gestation, and after parturition the F<sub>1</sub> dams and their F<sub>2</sub> offspring (six kits in each litter) were measured in the second and fourth weeks of lactation. Blood was drawn once a week from the F<sub>1</sub> dams for hormone analyses. Eight F<sub>1</sub> dams were euthanized in late gestation for tissue collection from dams and fetuses for determination of gene expression of key hepatic gluconeogenic and glycolytic enzymes.

**Results and Discussion:** The quantitative metabolic traits of the F<sub>1</sub> dams were unaffected by protein supply during foetal life, but ME intake (2082 vs 1816 kJ/kg<sup>0.75</sup>) was significantly ( $p = 0.02$ ) higher, and the retained energy (247 vs 4 kJ/kg<sup>0.75</sup>) tended ( $p = 0.10$ ) to be higher among FL than FA during the fourth week of lactation. The F<sub>2</sub> offspring of FL dams had significantly ( $p = 0.003$ ) higher birth weight than those of FA dams (12.2 vs 11.1 g). Plasma concentrations of leptin, insulin and IGF-1 were not affected by *in utero* protein supply but insulin ( $p = 0.09$ ) and IGF-1 ( $p = 0.1$ ) tended to be lower among FL than FA F<sub>1</sub> dams. No significant differences in the relative abundances of G-6-Pase, Fru-1,6-P<sub>2</sub>ase, PKM<sub>2</sub> and PEPCK mRNA in hepatic tissue between FL and FA dams were found. Despite this, the relative abundance of PKM<sub>2</sub> mRNA (3.1 vs 13.7) was significantly ( $p = 0.007$ ) lower, and that of Fru-1,6-P<sub>2</sub>ase mRNA (2.9 vs 5.6) tended ( $p = 0.08$ ) to be lower in hepatic tissue of F<sub>2</sub> fetuses of FL than FA F<sub>1</sub> dams.

**Conclusion:** Our study confirms that epigenetic changes in hepatic enzymes affecting glucose homeostasis can be transmitted from the F<sub>1</sub> to the F<sub>2</sub> generation in mink exposed to foetal life protein restriction. A possible cause of the higher birth weights of FL offspring might be maternal gestation hyperglycemia which, however, remains to be confirmed.

### References:

- Lucas A (1991) *Ciba Foundation Symposium* 156, 38-55.  
Pinheiro AR, Salvucci IDM, Aguila MB & Mandarim-de-Lacerda CA (2008) *Clin Sci* 114, 381-392